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(54) Gear type transmission

(57) Input and output shafts 2,3 are coaxially aligned, with an interposed clutch 5, and a countershaft 4 is arranged parallel with them. A first group of gear units 6,7 each including constantly meshed paired gears, are arranged between the input shaft 2 and the countershaft 4 to establish therebetween various gear ratios, and a second group of gear units 9,10 each including constantly meshed paired gears, are arranged between the countershaft 4 and the output shaft 3 to establish therebetween various gear ratios.

FIG. 1

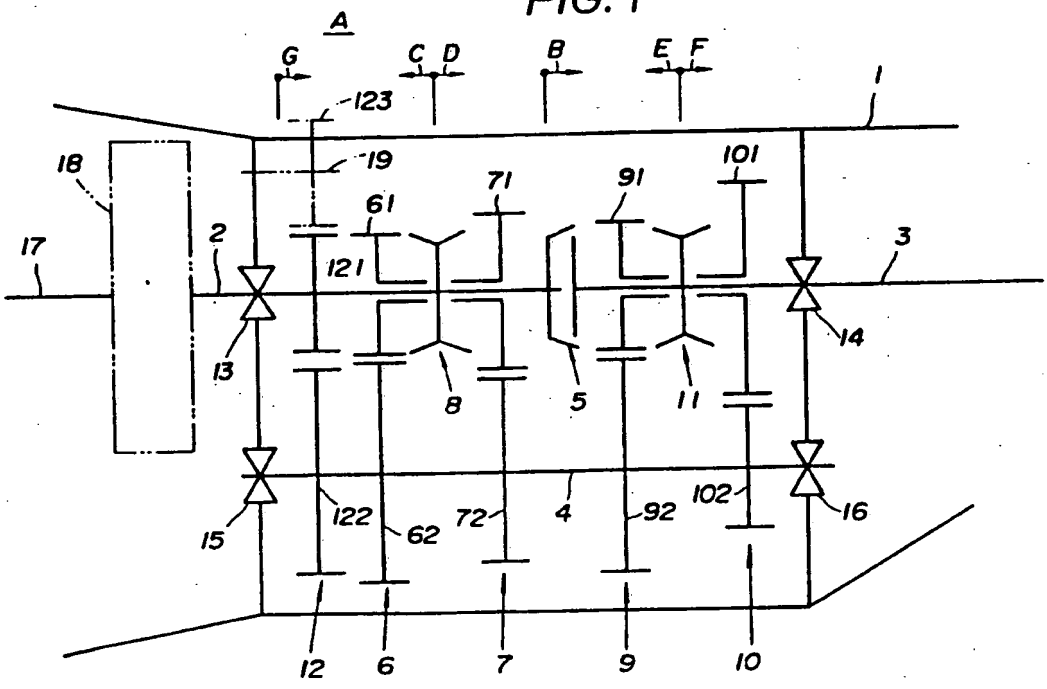

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FIG. 1

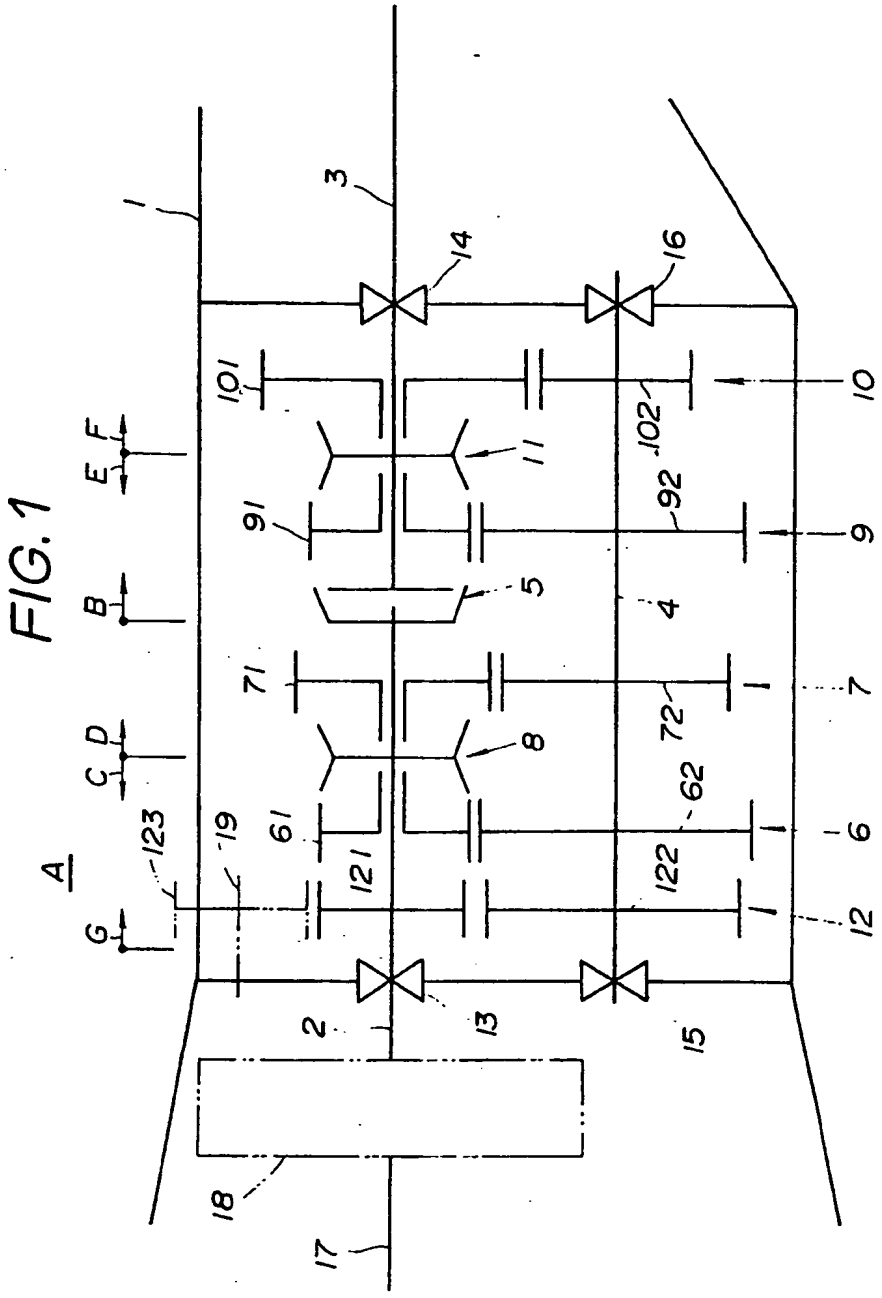

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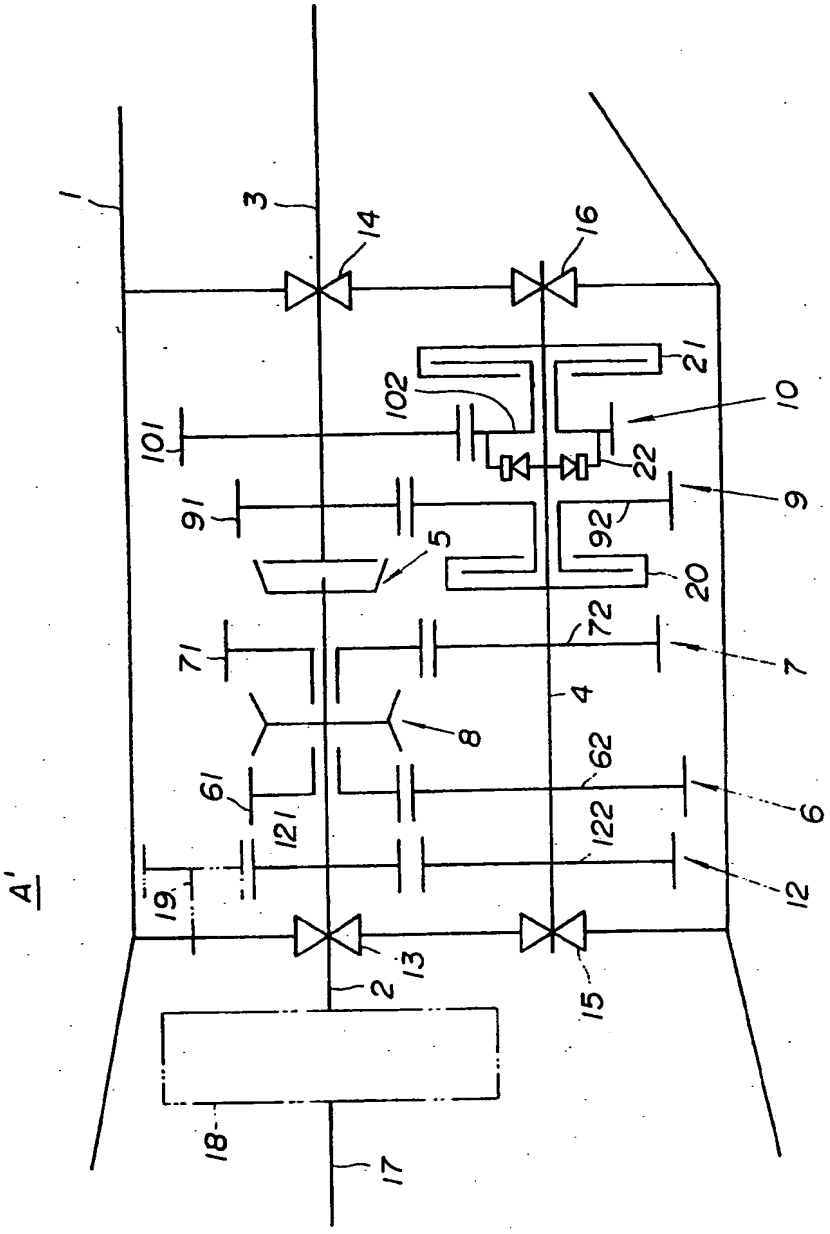
FIG.2



SPECIFICATION

Gear type transmission

The present invention relates to a gear type transmission for use in a wheeled motor vehicle.

Hitherto, various kinds of gear type transmissions have been proposed and put into practical use particularly in the field of the wheeled motor vehicles. One of the transmissions hitherto proposed is shown in Japanese Publication titled "POWER TRANSMISSION DEVICE" issued on November 20, 1980 by SANKAIDO Co., Ltd., which is designed to have five forward speeds (one overdrive) and one reverse. The transmission disclosed by the publication is of a so-called "Countershaft Type" in which input and output shafts are coaxially aligned and a countershaft is arranged beside the input and output shafts to extend parallel with the same. A drive gear unit (including paired gears) is arranged between the input shaft and the countershaft to transmit power from the input shaft to the countershaft, and third, second, first and fifth speed gear units (each including paired gears) are arranged in this order from the drive gear unit between the countershaft and the output shaft to selectively transmit power from the countershaft to the output shaft. A fourth speed synchronizer is arranged between the input shaft and the output shaft to smoothly and directly connect them for obtaining the fourth speed. A first-second speed synchronizer is arranged on the output shaft to associate with both the first and second speed gear units, a third speed synchronizer is arranged on the output shaft to associate with the third speed gear unit, and a fifth speed synchronizer is arranged on the output shaft to associate with the fifth speed gear unit.

However, as is described hereinabove, in the conventional transmission, five gear units, that is, ten gears are inevitably needed for obtaining the five forward speeds due to the inherent construction of the transmission. As will become understood hereinafter, usage of five gear units causes a high cost production.

Furthermore, since, in such a transmission, larger diameter gears of the low speed gear units (viz., first and second gear units) are arranged on the output shaft due to the inherency of the transmission, the synchronizer associated with them is subjected to a great load upon operation thereof. Thus, considerably large force is needed for carrying out the speed change.

Furthermore, because of the provision of the drive gear unit including constantly meshed two gears which rotate together with the input shaft even under neutral condition of the transmission, gear noise trouble is marked.

What is desired is a gear type transmission which is free of the above-mentioned drawbacks.

An improved gear type transmission which is embodied by paying attention to the fact that in the conventional manual gear transmission, the rate (r1/r2) of the gear ratio (r1) of the first speed to that (r2) of the second speed is generally the same as the rate (r3/r5) of the gear ratio (r3) of the third speed to that (r5) of the fifth speed.

According to the present invention, there is provided a gear type transmission which comprises input and output shafts coaxially aligned and rotatable about the common axis thereof; first clutch means arranged between the input and output shafts to directly connect them when actuated; a countershaft arranged beside the aligned input and output shafts in a manner to extend parallel with the common axis; a first group of gear units each including constantly meshed paired gears, the first group of gear units being arranged between the input shaft and the countershaft to establish therebetween various gear ratios; and a second group of gear units each including constantly meshed paired gears, the second group of gear units being arranged between the countershaft and the outut shaft to establish therebetween various gear ratios.

Other objects and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic illustration of a gear type transmission of a first embodiment of the present invention; and

Figure 2 is a view similar to Fig. 2, but showing a second embodiment of the present invention.

Referring to Fig. 1, there is schematically shown a gear type transmission of a first embodiment of the present invention, which is generally designated by reference "A". As will become apparent as the description proceeds, the transmission "A" is of a five forward speeds (including one overdrive) and one reverse type which is applicable to automobiles.

The gear type transmission "A" of the first embodiment comprises a transmission casing 1, an input shaft 2, an output shaft 3, a countershaft 4, a fourth speed clutch 5, a first/third speed gear unit 6, a second/fifth speed gear unit 7, a first synchronizer 8, a high speed gear unit 9, a low speed gear unit 10, a second synchronizer 11, and a reverse gear unit 12.

The input and output shafts 2 and 3 are coaxially aligned and the countershaft 4 is arranged parallel to the coaxial shafts 2 and 3. The three shafts 2, 3, and 4 are housed in the transmission casing 1 through bearings 13, 14, 15, and 16.

mechanism 18. A friction clutch or a torque converter is usable as the clutch mechanism 18.

The outer shaft 3 is connected to driving wheels (not shown) of the associated motor vehicle through a known mechanism.

As will become apparent hereinafter, the countershaft 4 transmits the power of the input shaft 2 to the output shaft 3 when the transmission "A" assumes the first speed, second speed, third speed, fifth speed or reverse condition.

The fourth speed clutch 5 is arranged between the input shaft 2 and the output shaft 3, so that upon engagement of the clutch 5, these two shafts 2 and 3 are directly connected to obtain the fourth speed condition. The fourth speed clutch 5 is equipped with a hydraulic actuator (not shown), so that upon selection of the fourth speed condition, a part of the clutch 5 on the input shaft 2 is moved rightward in the drawing (that is, in the direction of the arrow B) to establish the clutch engagement.

The first/third speed gear unit 6 comprises a first input gear 61 rotatably disposed on the input shaft 2 and a first counter gear 62 securely disposed on the counter shaft 4. These two gears 61 and 62 are constantly meshed with each other.

The second/fifth speed gear unit 7 comprises a second input gear 71 rotatably disposed on the input shaft 2 and a second counter gear 72 securely disposed on the counter shaft 4. These gears 71 and 72 are constantly meshed with each other.

Upon speed change operation, the first synchronizer 8 sychronizes the rotation of the input shaft 2 and a selected gear (viz., the first input gear 61 or the second input gear 71) and then engages the selected gear with the input shaft 2. The first synchronizer 8 is arranged between the first input gear 61 and the second input gear 71 as shown.

The first synchronizer 8 is equipped with a hydraulic actuator (not shown), so that upon selection of the first or third speed condition, a sleeve of the first synchronizer is moved leftward in the drawing (that is, in the direction of the arrow C) to fix the gear 61 to the input shaft 2, and upon selection of the second or fifth speed condition, the sleeve is moved rightward (that is, in the direction of the arrow D) to fix the gear 71 to the input shaft 2.

The high speed gear unit 9 comprises a first output gear 91 rotatably disposed on the output shaft 3 and a third counter gear 92 securely disposed on the counter shaft 4. The gears 91 and 92 are constantly meshed with each other.

The low speed gear unit 10 comprises a second output gear 101 rotatably disposed on the output shaft 3 and a fourth counter gear 102 securely disposed on the counter shaft 4. The gears 101 and 102 are constantly meshed with each other.

The second synchronizer 11 is arranged between the first output gear 91 and the second output gear 101 and equipped with a hydraulic actuator (not shown), so that upon selection of the high speed condition (viz., third or fifth speed condition), the sleeve of the synchronizer 11 is moved leftward in the drawing (that is, in the direction of the arrow E) to fix the gear 91 to the output shaft 3, and upon selection of the low speed condition (viz., first or second speed condition), the sleeve is moved rightward (that is, in the direction of the arrow F) to fix the gear 101 to the output shaft 3.

The reverse gear unit 12 comprises a reverse gear 121 securely disposed on the input shaft 2, a reverse counter gear 122 securely disposed on the counter shaft 4, and a reverse idler gear 123 axially slidably disposed on an idler shaft 19. The reverse idler gear 123 is equipped with a hydraulic actuator (not shown), so that upon selection of the reverse condition, the reverse idler gear 123 is moved rightward in the drawing (that is, in the direction of the arrow G) to engage with both the reverse gear 121 and the reverse counter gear 122.

The number of teeth of each gear for forward mode and the gear ratio i–a, i–b, i–c, or i–d of each gear unit 6, 7, 9, or 10 are shown in TABLE 1.

TABLE 1

Gear on input or output shaft	Gear 61	Gear 71	Gear 91	Gear 101
Number of teeth	13	19	16	24
Gear on Countershaft	Gear 62	Gear 72	Gear 92	Gear 102
Number of teeth	25	21	21	13
Gear Ratio	i-a 1.923 (25/13)	i-b 1.105 (21/19)	i-c 0.762 (16/21)	i-d 1.846 (24/13)

In the following, operation of the first embodiment "A" will be described.

(1) Under neutral condition

Under neutral condition, the hydraulic actuators do not work, so that power transmission from the input shaft 2 to the output shaft 3 does not take place. The parts which are forced to rotate under this neutral condition are only the first synchronizer 8 provided on the input shaft 2, a part of the fourth clutch 5 and the reverse gear 121, and none of the gear units assumes power transmission condition.

(2) Under first speed condition

Under the first speed condition, due to the work of the hydraulic actuators, the first input gear 61 is fixed to the input shaft 2 and the second output gear 101 is fixed to the output shaft 3. Thus, the power transmission path established in this condition comprises the input shaft 2, the first synchronizer 8, the first input gear 61, the first counter gear 62, the counter shaft 4, the fourth counter gear 102, the second output gear 101, the second synchronizer 11 and the output shaft 3. The speed change ratio r1 ($=(i-a)\times(i-d)$ at this first speed condition is 3.550.

(3) Under second speed condition

Under the second speed condition, due to the work of the hydraulic actuators, the second input gear 71 is fixed to the input shaft 2 and the second output gear 101 is fixed to the output shaft 3. Thus, the power transmission path established in this condition comprises the input shaft 2, the first synchronizer 8, the second input gear 71, the second counter gear 72, the counter shaft 4, the fourth counter gear 102, the second output gear 101, the second synchronizer 11, and the output shaft 3. The speed change ratio r2 ($=(i-b)\times(i-d)$) at this second speed condition is 2.040.

(4) Under third speed condition

Under the third speed condition, due to the work of the hydraulic actuators, the first input gear 61 is fixed to the input shaft 2 and the third counter gear 92 is fixed to the output shaft 3. Thus, the power transmission path in this condition comprises the input shaft 2, the first synchronizer 8, the first input gear 61, the first counter gear 62, the counter shaft 4, the third counter gear 92, the first output gear 91, the second synchronizer 11, and the output shaft 3. The speed change ratio r3 ($=(i-a)\times(i-c)$) at this condition is 1.407.

(5) Under fourth speed condition

Under the fourth speed condition, the fourth speed clutch 5 is engaged, so that the power of the input shaft 2 is directly transmitted to the output shaft 3 without making a speed change therebetween. That is, the speed change ratio r4 at this fourth speed is thus 1.000.

(6) Under fifth speed condition

Under the fifth speed condition, the second input gear 71 is fixed to the input shaft 2 and the

lished in this condition comprises the input shaft 2, the first synchronizer 8, the second input gear 71, the second counter gear 72, the counter shaft 4, the third counter gear 92, the first output gear 91, the second synchronizer 11, and the output shaft 3. The speed change ratio r5 (=(i−b)×(i−c)) at this fifth speed is 0.842, so that the rotation speed of the output shaft 3 is greater than that of the input shaft 2.

(7) Under reverse condition

Under the reverse condition, due to the work of the hydraulic actuators, the reverse idler gear 123 is moved in the direction of the arrow G to engage with the gears 121 and 122 and the second output gear 101 is fixed to the output shaft 3. Thus, the power transmission path at this condition comprises the input shaft 2, the reverse gear 121, the reverse idler gear 123, the reverse counter gear 122, the counter shaft 4, the fourth counter gear 102, the second output gear 101, the second synchronizer 11, and the output shaft 3. By the provision of the reverse idler gear 123, the rotational direction of the output shaft 3 is reversed to that of the input shaft 2.

As is understood from the foregoing description, in the transmission "A" of the first embodiment, the five forward speed conditions are available with only "four" speed gear units 6, 7, 9, and 10 (viz., eight gears 61, 62, 71, 72, 91, 92, 101, and 102), unlike the case of the afore-mentioned conventional transmission which uses "five" speed gear units. As is known, reduction in number of parts induces not only economical merits but also easy assembly of parts in the transmission casing.

Furthermore, in the first embodiment, even the low speed conditions (viz., first speed or second speed condition) can be achieved by suitably combining the gear units of smaller speed reduction ratio in the afore-mentioned manner. Thus, unlike the case of the afore-mentioned conventional transmission, the smaller diameter low speed gears (viz., the gears 61 and 71 of the first and second speed gear units 6 and 7) can be arranged on the input shaft 2 thereby reducing the load applied to the first synchronizer 8 arranged therebetween. Thus, the speed change can be carried out with a smaller operating force. This merit is particularly marked when actuators powered by hydraulic pressure, vacuum, or electricity are employed for producing such operating force.

Furthermore, in the first embodiment, there is no gear unit which carries out the power transmission work in the neutral condition, the gear noise originating from rotational fluctuation of the engine at the engine idling is not produced or at least minimized.

Referring to Fig. 2, there is shown a second embodiment "A'" of the present invention. In the gear type transmission A' of this embodiment, the first output gear 91 of the high speed gear unit 9 and the second output gear 101 of the low speed gear unit 10 are securely disposed on the output shaft 3. The third counter gear 92 is rotatably disposed on the countershaft 4 through a first clutch 20, while the fourth counter gear 102 is rotatably disposed on the countershaft 4 through a second clutch 21 and a one-way clutch 22. The first and second clutches 20 and 21 are respectively provided with hydraulic actuators (not shown). The remaining parts are arranged in substantially the same manner as the first embodiment, as shown. It is to be noted that the second embodiment A' uses the first and second clutches 20 and 21 as a substitute for the second synchronizer 11 of the first embodiment. Thus, upon energization of the associated actuator, the first clutch 20 or the second clutch 21 engages the third counter gear 92 or the fourth counter gear 102 to the counter shaft 4.

Upon selection of the first or second speed condition, the second clutch 21 is engaged and thus fixes the fourth counter gear 102 to the counter shaft 4, while, upon selection of the third or fifth speed condition, the first clutch 20 is engaged and thus fixes the third counter gear 92 to the counter shaft 4.

Because of the provision of the one-way clutch 22, the first or second speed condition is available without aid of the second clutch 21. When the power transmission is being carried out through the one-way clutch 22, the vehicle coasting (viz., the vehicle movement by only the inertia) improves fuel mileage because, under such condition, engine brake is not effected.

By the provision of the one-way clutch 22, the actuators of the first and second clutches 20 and 21 can use, as a power source, the hydraulic pressure produced by a hydraulic pump driven by the output shaft 3 or the counter shaft 4.

Description of the operation of the second embodiment will be omitted because the operation of the same is substantially the same as that of the first embodiment A except for the modified arrangement as described hereinabove.

CLAIMS

1. A gear type transmission comprising:

input and output shafts coaxially alignedand rotatable about the common axis thereof;

first clutch means arranged between the input and output shafts to directly connect them

a countershaft arranged beside the aligned input and output shafts in a manner to extend parallel with the common axis;

a first group of gear units each including constantly meshed paired gears, the first group of gear units being arranged between the input shaft and the countershaft to establish therebetween various gear ratios; and

a second group of gear units each including constantly meshed paired gears, the second group of gear units being arranged between the countershaft and the output shaft to establish therebetween various gear ratios.

2. A gear type transmission as claimed in claim 1, further comprising second clutch means which, when actuated, smoothly connects one given gear of the paired gears of each group to the corresponding shaft on which the given gear is rotatably disposed.

3. A gear type transmission as claimed in claim 2, in which the second clutch means comprises a synchronizer which, when actuated, equalizes the rotation speed of the given gear with that of the corresponding shaft before connection therebetween.

4. A gear type transmission as claimed in claim 3, in which the second clutch means further comprises a one-way clutch which is incorporated with one given gear of the paired gears of the second group, the one-way clutch being arranged so that the power transmission from the corresponding shaft to the given gear is permitted only when the corresponding shaft rotates in a predetermined direction.

5. A gear type transmission as claimed in any preceding claim, in which the first group of gear units comprises:

first and second input gears rotatably disposed on the input shaft; and

first and second counter gears securely disposed on the countershaft and constantly meshed with the first and second input gears respectively.

6. A gear type transmission as claimed in claim 5, further comprising a first synchronizer which is arranged between the first and second input gears to smoothly connect either one of the first and second input gears to the input shaft.

7. A gear transmission as claimed in claim 6, in which the second group of gear units comprises:

first and second output gears rotatably disposed on the output shaft; and

third and fourth counter gears securely disposed on the countershaft and constantly meshed with the first and second output gears respectively.

8. A gear type transmission as claimed in claim 7, further comprising a second synchronizer which is arranged between the first and second output gears to smoothly connect either one of the first and second output gears to the output shaft.

9. A gear type transmission as claimed in claim 6, in which the second group of gear units comprises:

first and second output gears securely disposed on the output shaft; and

third and fourth counter gears rotatably disposed on the countershaft and constantly meshed with the first and second output gears respectively.

10. A gear type transmission as claimed in claim 9, further comprising first and second clutches which are respectively incorporated with the third and fourther counter gears, each clutch connecting the associated counter gear to the countershaft when actuated.

11. A gear type transmission as claimed in claim 10, further comprising a one-way clutch which is incorporated with one of the third and fourth counter gears, the one-way clutch being arranged so that the power transmission from the countershaft to the associated counter gear is permitted only when the countershaft rotates in a predetermined direction.

12. A gear type transmission substantially as described with reference to, and as shown in, Fig. 1 or Fig. 2 of the accompanying drawings.

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